In today’s challenging scenario, the substation is becoming more and more a key element to meet end users requirements successfully and economically. The need of the time is to have substations which have:

- high reliability and availability of the substation
- reduced time of equipment installation
- less space requirement
- simplified layout
- less maintenance required (maintenance on demand);
- good cost performance
- environment friendly: recycling / disposal at end of life

New substations have to meet tough requirements in terms of occupied space, environment and availability. Many existing substations have outlived their operational life and a one-to-one replacement of conventional AIS components like circuit-breakers and Disconnectors is not economically advisable. Substation extensions require high flexibility on primary equipment, to cope with already existing control systems, lack of available space, limited down time.

In this article, the authors discuss a reliable, simplified, maintenance free, factory tested and environment friendly solutions using “Hybrid Switchgear” to meet the above mentioned challenges. This concept is a hybrid of traditional air insulated (AIS) and SF6 metal-clad gas insulated (GIS) switchgear units designed as self-contained switching modules suitable for use in outdoor substations. It combines all the typical functions of a complete AIS bay for electrical substations in a unit whose volume is comparable to that of a conventional circuit-breaker of equal class.

**General**

There has been a practice since long to install equipments in a substation to combine functionality to reduce the cost and installation time. For example, current transformer installed on a dead tank circuit breaker or installation of a current transformer on same structure on which a circuit breaker is installed has been popular since long. Figure 1 gives an example where a current transformer and a circuit breaker are installed on same structure.

With increase in such requirements and innovative solutions been offered by manufacturers, IEC have come out with IEC standard 62271 – 205, Compact switchgear assemblies for rated voltages above 52 kV [1].

Taking clue from the Gas Insulated Substation (GIS) and dead tank circuit breakers innovative switchgears
have been designed where all functions except busbars can be integrated. Such solutions offer the reliability of the GIS and cost advantage of Air Insulated Substation (AIS). The following sections discuss such solution which gives various possibilities in substation design and experience with the Indian customers.

**User's Changing Requirements**

With privatization of the electrical energy industry and usage of automation in the industry new demands on the performance of the equipment have come up. They are namely;

- Life Cycle Cost of the substation to come down
- Installation of the substation in shortest time – very important parameter in certain application like solar
- Improvement in the performance of the equipment that gives improved reliability and availability – higher availability means improved revenue specially in power segment
- Reduced space requirement with a possibility of expanding existing substation with limited space.
- Avoid/ minimize outage due to any repair/ maintenance
- Reduced footprint and hence less civil work

Traditionally GIS has been used where such requirements have to be met. GIS has been giving such advantages as SF6 gas has been used as insulation and all the components are housed in SF6 gas. However, the cost has been main factor while selecting GIS. Thus GIS have been used only when performance or space constraints outweigh cost considerations. With the concept of hybrid / mixed technology switchgear, it is possible to derive performance benefits of GIS and cost advantage of AIS.

**What Is Hybrid Or Mixed Technology Switchgear?**

Hybrid switchgear is compact switchgear where the functionality of the substation switchgear is integrated in gas insulated enclosure. The busbar in such substation is traditional air insulated. The functionality component is modular in nature. Figure 2 gives a photograph of hybrid installation.

![Figure 2: Installation of 66 kV Hybrid Switchgear at Aatash Power 5 MW Solar Power Project at Sabarkantha, Gujarat](image)

One can see that the unit is factory assembled and tested. The equipment is standing on one foundation. This makes it possible to install by avoiding installation errors at site very quickly.

**The Benefits**

**Space Saving**

As the number of functions are integrated, the distance between components reduces to practically zero. For the AIS, as we have to maintain the clearances between individual equipments like CB,
CT, Disconnectors, earth switch etc. the bay length required is more. Where as, with the hybrid switchgear the bay length is reduced as CB, CT & disconnector-earth switch functions are integrated in one module. This gives over all reduction in the area required for the substation. Figure 3 gives the comparative area requirement for the AIS and hybrid switchgear.

With reduction in area one can accommodate more bays in same space. The area reduction can be varying depending on the integration of functionality. It can be as high as 60%.

Reduction in area has two advantages.

- For a new substation, one can have less area resulting in reduced land cost.
- Reduced cost due to reduced civil cost, clamps & connectors, earthing, shielding requirements, fencing etc.

This concept is also useful when there is a constraint on the space in existing substation where extension is required to be done or where the space is really constraint.

**Reduction in Installation time**

The assemblies are pre-tested in the factories and very little work needs to be performed at site during installation and commissioning. As all the equipments are integrated in one module, very little civil work is required. As can be seen in Figure 2, there is only one set of foundation and the equipment can be installed and commissioned in very short time. For example, the equipment shown in figure 2 can be commissioned within 2 days after handing over of site. For conventional AIS this would have taken around 20 days for one complete bay.

This makes it possible to cut down on the substation execution time to very minimum. This is becoming more and more popular mainly in solar power plants to meet the short project timeline.

**Improvement in Reliability**

As the components of the switchgear are enclosed in SF6 gas it offers the highest reliability as achieved in GIS as only the bus bars are exposed to external environment and rest of the switching components are gas insulated.

**Cost Advantage**

General perception regarding the new technology is that it is expensive as compared to the existing technology. New technologies provide new solutions which are not one to one replacement. New technologies generally give added functionality. Hence, it may be necessary to look at the cost aspects from the overall perspective of the product life cycle. For example, the substation
costs include not only the cost of the equipment. It also includes cost of foundations, earthing, busbars, land, maintenance etc.

**Conclusions**

Based on the experience and the performance of the hybrid switchgears, following conclusions may be drawn.

- Hybrid switchgear offer compact solution for the substation design. This allows innovative way of installation with various advantages.
- The substations can be installed very quickly from the stage of conception. This is a growing requirement of the present day when the time to execute the project is reducing like in solar power projects wherein the overall project timeline is very stringent.
- It provides reduction in space requirement as compared to conventional AIS substations. It also gives possibility for future expansion within limited space.

**REFERENCES**

[1] IEC Standard 62271 – 205, Compact switchgear assemblies for rated voltages above 52 kV.
